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Longitudinal study of low and high achievers in early mathematics

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Background. Longitudinal studies allow us to identify, which specific maths skills are weak in young children, and whether there is a continuing weakness in these areas throughout their school years.

Aims. This 2-year study investigated whether certain socio-demographic variables affect early mathematical competency in children aged 5–7 years.

Sample. A randomly selected sample of 127 students (64 female; 63 male) participated. At the start of the study, the students were approximately 5 years old ($M = 5.2$; $SD = 0.28$; range = 4.5–5.8).

Method. The students were assessed using the Early Numeracy Test and then allocated to a high ($n = 26$), middle ($n = 76$), or low ($n = 25$) achievers group. The same children were assessed again with the Early Numeracy Test at 6 and 7 years old, respectively. Eight socio-demographic characteristics were also evaluated: family model, education of the parent(s), job of the parent(s), number of family members, birth order, number of computers at home, frequency of teacher visits, and hours watching television.

Results. Early Numeracy Test scores were more consistent for the high-achievers group than for the low-achievers group. Approximately 5.5% of low achievers obtained low scores throughout the study. A link between specific socio-demographic characteristics and early achievement in mathematics was only found for number of computers at home.

Conclusions. The level of mathematical ability among students aged 5–7 years remains relatively stable regardless of the initial level of achievement. However, early screening for mathematics learning disabilities could be useful in helping low-achieving students overcome learning obstacles.

Johannes E. H. Van Luit was mistakenly omitted from the authorship of this paper when it was first published online on 9th August 2011, this was corrected on 11th November 2011.

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Differences in the level of mathematics skills contribute more to the variance in work productivity, income, and employment among individuals than even reading ability and intelligence (Fuchs *et al.*, 2009). In the global school-age population, the prevalence of mathematics learning disability has been shown to be from 5% to 9% (Geary, 2004; Jordan, 2007). Mathematics learning disability is a serious problem for the individuals concerned because of its negative effect on their lifelong learning ability and career opportunities. Therefore, it is important to identify ways to prevent or at least reduce the difficulties encountered by learners of mathematics. Research has shown that early intervention activities can improve performance in mathematics substantially (Clements & Sarama, 2007). However, not all approaches are effective for all students. For example, after a 1-year intervention programme for first-grade students (6–7 years old) in the United States, approximately 3%–6% of the school population continued to manifest severe deficits in their level of achievement in mathematics (Compton, Fuchs, & Fuchs, n.d.). The early identification of children at risk of low achievement in mathematics is crucial because it provides the opportunity to mitigate the consequent effects on school and lifelong learning (Jordan, Kaplan, Locuniak, & Ramineni, 2007).

Longitudinal studies enable the identification of specific characteristics of young children with weak mathematical skills, and whether these continue to manifest throughout their school years. Some of these studies have specifically assessed children with learning disabilities in mathematics and identified several predictor variables for low achievement in mathematics. For instance, in respect of first grade students in the United States, Jordan *et al.* (2007) found that performance with respect to number sense (i.e., abilities related to counting, number patterns, comparisons of magnitude, estimating, and number transformation) accounted for 66% of the variance in achievement in mathematics. Focusing on a younger age group, Desoete and Grégoire (2006) used the Tedi-Math test (Grégoire, Van Nieuwenhoven, & Noël, 2004) and the Kortrijkse Rekentest Revision test (Baudonck *et al.*, 2006) to assess kindergarten children in Belgium and found that numerosity (numerical skills involved in subitizing and in estimating number size) is related to computational knowledge, logical knowledge, and counting skills. Mazzocco and Thompson (2005) found that it is possible to predict effectively which kindergartners are at risk of mathematical learning disability through the assessment of their visual–spatial reasoning, rapid automatic naming, and formal and informal mathematical abilities.

Longitudinal studies have also been conducted to investigate early performance in mathematics more generally. For instance, Aubrey, Godfrey, and Dahl (2006) tracked students in the United Kingdom through primary school during the first 5 years of the National Numeracy Strategy (DfEE, 2000) and found that children who have numerical and mathematical knowledge before they start primary school appear to be advantaged in terms of their mathematical progress during primary school. Another longitudinal study investigated the early numeracy skills of 511 children for evidence of low mathematical performance, and found differences in counting skills between individuals at age 6 (Aunio, Hautamäki, Sajaniemi, & Van Luit, 2009). A 2-year longitudinal case study of children in Sydney, Australia described the development of conceptual structures in mathematics and showed some progress for most children in terms of their achievement scores across counting, partitioning, measurement, and spatial tasks (Mulligan, Mitchelmore, & Prescott, 2005).

The relationship between cognitive variables and mathematical achievement has also been investigated. For instance, De Smedt *et al.* (2009) carried out a 2-year longitudinal study that examined the relationship between Baddeley's working memory model and differences between individuals with respect to their mathematical skills. The researchers found that working memory was related significantly to achievement in mathematics in first and second graders (6–8 years old).

None of the above-mentioned studies considered the effect of the socio-demographic background of the children on their mathematical performance. However, Krajewski and Schneider (2009) did study the influence of socio-economic status, which they assessed by using questionnaires to ascertain the educational status, training, and current profession of the parent(s). These variables were then compared with number naming speed in a 4-year longitudinal study of children in Germany from kindergarten to grade 4 (5–9 years old). The researchers concluded that the influence of socio-demographic background became important at the end of grade 4. A study conducted a few years earlier by Aunio, Hautamäki, Heiskari, and Van Luit, (2006) on children aged 4–7 in Finland explored the influence of demographic variables, such as hand preference, education of the parent(s), number of children in the family, birth order, and family model. They found that the mother's level of education had a statistically significant effect on the child's score in the Early Numeracy Test (ENT) (Van de Rijt, Van Luit, & Pennings, 1999), namely, the higher the level of the mother's education, the higher the child's score. In addition, the number of children in the family was shown to have an effect on the children's ENT scores: those from families with two or three children did better than those from families with one child or more than three children. The ENT comprises two subscales, namely, the relational scale and the numerical scale. It was found that girls performed better than boys on the total scale and on the relational scale.

The Programme for International Student Assessment (PISA) report from the Organization for Economic Co-operation and Development (OECD, 2006) also considered the importance of socio-demographic variables, including the education of the parent(s), job of the parent(s), and number of books at home, on achievement in mathematics, specifically in Spanish secondary schools. This report focused on children aged 15 and found that the above-mentioned variables affected achievement in mathematics. In contrast, in the study reported herein, we examined how the following socio-demographic variables were related to mathematics performance: the number of hours watching television, number of computers at home, parental supervision, and frequency of teaching visits. Features such as the education and professional qualifications of the mother were also thought to be of potential importance. An extensive study carried out within the Spanish educational system in secondary level (Calero, Quiroga, Oriol, Waisgrais, & Mediavilla, 2008) showed the importance of the educational qualifications of the parent(s), particularly those of the mother, in relation to the mathematical achievement of the child. For example, having a father with a university education increased the probability of the child reaching the highest levels of education by 2.5 times, whereas the probability rose by 2.8 times if the mother alone had a university degree. Sociological studies on childcare have found that, traditionally, in Spain, mothers have a greater role than fathers in the supervision of school work. For this reason, if a greater number of mothers are educated to university level, this should increase the number of children that will receive effective help in mathematics from an early age, and thus reduce difficulties in learning mathematics later on.

Aims

Much valuable information has been gained from the longitudinal research studies that have been carried out in various countries over the past decade. In the study described herein, we aimed to add to the knowledge in this field by investigating the effect of eight socio-demographic variables on the mathematical performance of children during their last 2 years of kindergarten and first year of elementary school. The main goals of this study were twofold. First, to ascertain and monitor the early mathematical competency of students in kindergarten and the first grade of elementary school (approximate age range of 5–7 years) over a 2-year period by using the ENT Spanish version (Measurements 1, 2, and 3) (Van de Rijt *et al.*, 1999), and to identify low and high achievers (HA). Second, to analyse the relationship between eight socio-demographic variables – namely, and in no particular order, education of the parent(s), job of the parent(s), number of children, birth order, number of computers at home, hours watching television, frequency of teacher visits, and family model – and the mathematical performance of those students who were at risk of mathematics learning disabilities.

The research questions were formulated as follows: do the ENT scores for low and HA remain constant throughout the 2-year period of the longitudinal study (i.e., from the age of 5–7)? Is early low and/or high achievement in mathematics connected to socio-demographic characteristics and, if so, which characteristics do have the most impact?

Method

Participants

A selected sample of 127 students (64 female; 63 male) participated in this study. The study was conducted in five regular classes in three elementary schools that also contained kindergartens. Two classes were in School 1 ($n = 50$), two classes were in School 2 ($n = 50$), and one class was in School 3 ($n = 27$). All three schools were located in the Cadiz school district in Spain. In September 2004, at the beginning of this research study, the students were 5 years old ($M = 5.2$; $SD = 0.28$; range = 4.5–5.8). They were in the third academic year of kindergarten. The second evaluation was carried out in June 2005, at the end of that academic year, with the same children ($n = 127$). Then, 1 year later, in June 2006, the same students ($n = 122$; 60 female and 62 male) were assessed when they were in the last month of the first grade in elementary school. None of the participants had special educational needs.

Instruments: The ENT

The ENT Spanish version (Navarro *et al.*, 2009) was administered to all the participants. Three parallel assessments (Measurements 1, 2, and 3) were carried out at the time points described above. Each assessment with the ENT included 40 items that measured eight aspects of the mathematical competence of young children: (1) concepts for the comparison of quantitative and qualitative characteristics of objects; (2) classification of objects in classes or subclasses; (3) correspondence of one-to-one relations; (4) seriation of objects in classes or subclasses on the basis of specific criteria; (5) using counting words, forwards and backwards; (6) structured counting, synchronous counting, and shortened counting from the dice structure; (7) resultative counting, namely, counting structured and unstructured quantities as well as counting hidden quantities; and (8) general knowledge of numbers. From a theoretical point of view, the first four subscales of the test refer to the logical principles that have been identified as the key factors underlying children's understanding of quantities and relations (the relational element of the test) (Piaget, 1966). The other four subtests focus more explicitly on the use and understanding of numbers (the numerical element of the test) (Fuson, 1988; Gelman & Gallistel, 1978).

The ENT was administered to each participant on an individual basis. After the test, the answers were assessed by using the ENT scoring key. The correlation of the three parallel ENT assessments (Measurements 1, 2, and 3) was $r_{1,2} = .68$; $p < .01$; $r_{1,3} = .56$; $p < .01$; and $r_{2,3} = .63$; $p < .01$, which suggested that the consistency of the parallel ENT measurements was constructed in the same way from the same content domain. According to Cronbach's α, the reliability of the ENT was .95 for Measurement 1, .70 for Measurement 2, and .81 for Measurement 3, which demonstrated sufficient reliability.

Interview of parent(s)

After Measurement 1 had been performed, the parents of all the participants were asked to complete a questionnaire to obtain the socio-demographic data. The questionnaire included 12 short questions on the following topics: family model, education of the parent(s), job of the parent(s), number of family members, birth order, number of computers at home, frequency of teacher visits, and hours watching television. These topics were selected on the basis of the study of Aunio, Hautamäki, Sajaniemi, and Van Luit (2005).

Procedure

At stage 1 of the study in September 2004, 127 kindergarten students were assessed using the ENT (Spanish version). All students were tested individually in an appropriate office during school hours. Each evaluation took about 30 min. Measurement 2 was carried out 9 months later (June 2005) under the same general conditions and with the same children ($n = 127$). One year later in June 2006, Measurement 3 was conducted with a sample of 62 boys and 60 girls ($n = 122$). The same students were tested but the sample number was smaller because five children had moved to another city between June 2005 and June 2006, and therefore they were not assessed at stage 3. All tests were administered by the authors.

After ENT Measurement 1 had been administered, three groups were created by using quantitative group distribution criteria. Members of the low-achievers (LA) group had a score in the ENT of ≤ 1 *SD* below the general mean (≤ 10 points; $mean = 17.8$; $SD = 7.4$; $n = 25$). The HA scored one standard deviation above the general mean (≥ 25 points; $n = 26$). All the other students were considered middle achievers (MA) and had a score in ENT Measurement 1 of ≥ 11 and ≤ 24 points.

Results

All participants improved their ENT scores for the total scale and for the relational and numerical subscales over the course of the study (Table 1). 'All comparisons of relational versus numerical ENT scores were found to be significant'. (Measurement 1: $t(126) = 16.9$; $p < .01$; Measurement 2: $t(126) = 9.77$; $p < .01$; Measurement 3: $t(126) = 7.34$; $p < .01$). Correlations between measurements and students' age were calculated (Measurement 1, $r = .43$; $p < 0.01$; Measurement 2, $r = .28$; $p < .01$; and Measurement 3, $r = .20$; $p < .03$). A total score ≥ 33 was considered to be the ENT ceiling effect (max ENT total score is 40). Only two students achieved this score in Measurement 1 (n14 and n49 in the HA group). Eleven HA students scored above 33 points in Measurement 2, whereas just one scored above 33 in the LA group (n21) at this stage. In Measurement 3,

Table 1. Descriptive results for all subtests of the Early Numeracy Test (ENT) (Measurements 1, 2, and 3) taken by students aged 5–7 years old over a 3-year period

	Measurement 1 (*n* = 127)		Measurement 2 (*n* = 127)		Measurement 3 (*n* = 122)	
ENT	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Comparison	4.40	0.76	4.76	0.52	4.91	0.30
Classification	3.50	1.06	3.70	0.81	4.30	0.72
Correspondence	2.01	1.47	2.81	1.46	4.10	0.96
Seriation	1.55	1.48	2.74	1.43	3.97	1.16
Word counting	1.63	1.55	2.84	1.31	4.30	0.86
Structured counting	1.61	1.33	3.03	1.11	3.63	0.96
Resultative counting	0.99	1.17	2.70	1.36	3.70	1.08
General knowledge of numbers	2.08	1.46	2.53	1.40	4.08	1.00
Total relational	11.48	3.50	14.07	2.88	17.29	2.16
Total numerical	6.33	4.63	11.12	4.07	15.72	2.57
Total ENT	17.81	7.46	25.19	6.197	32.98	4.15

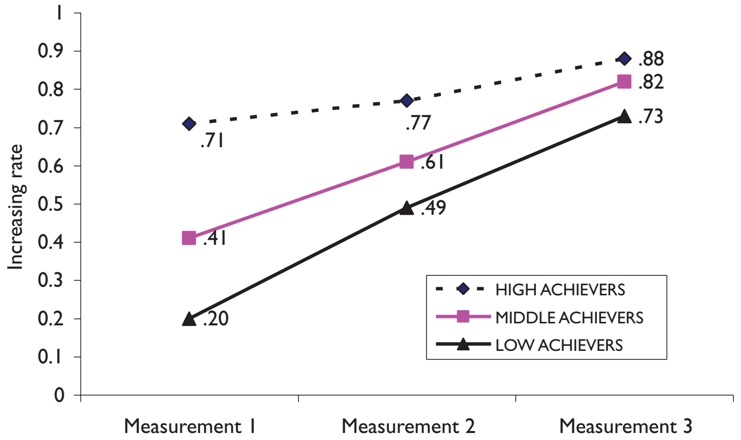

Figure 1. Increase in the percentage of correct scores in the Early Numeracy Test (Measurements 1, 2, and 3) for high-, middle-, and low-achiever groups. Increase in the percentage of correct scores was calculated by using the formula 'Mean group ENT total score'/'maximum points possible (n = 40)'

27 HA and seven LA students surpassed the ceiling effect score of 33. Differences in the scores for the relational and numerical subscales allowed us to make comparisons between logical knowledge and numerical knowledge. Such differences were found for the scores obtained in Measurements 1 and 2 when the students were at the end of kindergarten. All groups increased their scores across the three stages of the ENT assessment. We calculated the increase in the percentages of correct scores by: 'Mean group total ENT score'/'maximum points possible (n = 40)'. Figure 1 shows the results of this calculation. From the figure, it can be seen that the greatest increase was in the LA group (0.20–0.73).

Table 2 shows descriptive data for Measurements 1, 2, and 3 for the HA, MA, and LA participants, both for the total score in the ENT and for the relational and numerical subscores. Analysis of covariance (ANCOVA) for the HA, MA, and LA groups was carried

Table 2. Total, relational, and numerical mean (*SD*) scores for low (LA), middle (MA), and high (HA) achievers aged 5–7 years old in Measurements 1, 2, and 3 of the Early Numeracy Test (ENT)

		Measurement 1	Measurement 2	Measurement 3
LA	Total	8.04 *(1.87)*	19.90 *(4.9)*	29.50 *(3.34)*
	Numerical	1.12 *(1.20)*	7.5 *(3.40)*	14.20 *(1.87)*
	Relational	6.92 *(1.70)*	12.4 *(2.50)*	15.30 *(2.23)*
MA	Total	16.77 *(3.39)*	24.60 *(5.30)*	33.13 *(4.14)*
	Numerical	5.44 *(2.49)*	10.80 *(3.40)*	15.68 *(2.68)*
	Relational	11.33 *(2.25)*	13.70 *(2.70)*	17.44 *(2.00)*
HA	Total	28.43 *(3.16)*	30.90 *(4.20)*	35.53 *(2.55)*
	Numerical	12.80 *(2.88)*	14.70 (3.00)	17.10 *(2.07)*
	Relational	15.63 *(1.60)*	16.20 *(2.10)*	18.60 *(1.08)*

out, with the three measurements as dependent variables and age as covariate. Significant statistical differences were found for all three measurements: Measurement 1: F (2,219) = 221.43; $p < .01$; Measurement 2: F (2,646) = 24.94, $p < .01$; Measurement 3: F (2,204) = 14.93, $p < .01$. Moreover, *post hoc* test demonstrated statistical significance between the HA, MA, and LA groups for all three measurements ($p < .01$).

Of the participants who were assigned to the LA group after ENT Measurement 1, 13 (52%) of the children still performed poorly ($\leq$ 1 *SD* below the general mean) in ENT Measurement 2. Seven participants (28%) who were LA in kindergarten continued to exhibit the same low performance in ENT Measurement 3, at the end of the first grade of elementary school (Table 3). Most participants who were assigned to the HA group after ENT Measurement 1 (60%) also scored highly in Measurement 2. Furthermore, 95% of the HA students from ENT Measurement 2 maintained their performance in ENT Measurement 3 (Table 4).

To analyse whether there were any socio-demographic differences between the LA and HA students, we used a non-parametric test, because many of the socio-demographic variables investigated had an ordinal scale of measurement (e.g., family model, whether the parent(s) had a university degree, and job of the parent(s)). The only statistically significant difference in the demographic variables between HA and LA students was with respect to 'number of computers available at home' ($U = 127$; $p < .023$) (see Table 5). None of the other socio-demographic variables investigated showed statistical significance between HA and LA participants.

Discussion

The main aims of this study were to ascertain and monitor early mathematical competency among children in kindergarten and in the first grade, especially among low and high achievers, and to examine the relationship between socio-demographic variables and mathematical performance, in young students who were at risk of mathematics learning disabilities.

Of the students with a very low score in ENT Measurement 1 at the age of 5 years (third year of kindergarten), 28% also obtained a very low score in the third administration of the test (Measurement 3) upon finishing first grade (7 years old). The low scores were more evident in the numerical scale than in the relational scale. The results also tended

Table 3. Total scores in Measurements 1, 2, and 3 of the Early Numeracy Test for the 25 low-achieving students aged 5–7 years old

Low-achieving students	Measurement 1	Measurement 2	Measurement 3
n10	7	28	33
n12	7	21	23
n15	9	25	31
n21	9	36	37
n26	8	20	36
n28	10	24	35
n33	10	19	33
n36	6	13	32
n38	9	16	33
n43	5	14	27
n49	5	21	31
n50	9	16	30
n51	6	12	21
n58	7	18	28
n62	5	26	29
n63	8	14	29
n65	9	18	31
n67	10	30	32
n69	9	22	27
n71	10	24	31
n72	8	19	27
n78	9	19	28
n79	7	21	29
n93	9	13	26
n105	10	19	34
%	100%	52%	28%
Criteria	≤ 10	≤ 19	≤ 28
N	25	13	7

Note 1. Seven students (28%) consistently obtained low scores. For ease of reference their scores in Measurement 3 are shaded in grey.

to be consistent across the assessments for students with high scores in the ENT. In fact, 60% of the students who were assigned to the HA group (21 students) after Measurement 1 were also high achievers at the Measurement 2 stage; and 95% of the HA at the Measurement 2 stage also scored highly in Measurement 3. This consistency was greater for the HA group than for the LA group: seven of 25 students who were initially assigned to the LA group had improved their scores at Measurement 3. There were 15 participants with a low score in Measurement 3 (1 *SD* below average). Two of these were low-score group students for Measurement 1 and 2 (1.6% of the total sample). Seven students with a low score in Measurement 3 also had a low score for Measurement 2. And 13 students identified as low score in Measurement 3, did not have a low score in Measurement 1. So, 5.5% of participants scored below criteria on ENT for both Measurement 2 and 3 even after receiving a standard mathematics curriculum. These students are now in the sixth grade and their mathematical knowledge will be evaluated. Results after this future evaluation using the ENT and cognitive measurements will determinate the long-term

Table 4. Total scores in Measurements 1, 2, and 3 of the Early Numeracy Test for the 26 high-achieving students aged 5–7 years old

High-achieving students	Measurement 1	Measurement 2	Measurement 3
n7	31	32	33
n14	35	38	40
n17	29	30	37
n24	31	33	36
n30	29	31	34
n47	26	34	35
n59	28	27	34
n61	28	34	38
n68	28	29	36
n74	26	22	30
n84	28	35	39
n85	32	37	36
n89	31	35	40
n91	28	29	33
n94	36	37	37
n96	32	37	39
n97	26	31	36
n98	29	34	35
n108	27	33	36
n115	32	24	32
n118	29	33	39
n119	29	28	34
n120	28	29	33
n121	25	30	33
n126	31	31	34
n128	25	32	38
%	100%	60%	57%
Criteria	≥ 25	≥ 31	≥ 36
N	26	18	17

predictive value for number sense in math skills (Toll, Van der Ven, Kroesbergen, & Van Luit, 2011).

The scores of all the participants in the ENT increased with age and schooling. This finding confirms that the aspects of mathematical competence that are assessed by the test (relational and numerical) are associated with levels of development, and is in line with the findings of previous studies in different contexts (Aguilar, Navarro, Alcalde, Ruiz, & Marchena, 2005; Aunio, Ee, Lim, Hautamäki, & Van Luit, 2004; Navarro *et al.*, 2009). However, the ENT ceiling was not reached by the majority of LA students (out of a total of 25 initial LA students, only one reached this ceiling in Measurement 2 and seven in Measurement 3). This suggests that the standard school mathematics curriculum was not providing LA students with the skills required to achieve the ENT ceiling effect. LA students showed the highest rate of improvement; however, the difference in the level of achievement between the HA and LA groups continued to be significant throughout the period of this study, that is, in all three measurements. On the basis of our findings, we would suggest that it is crucial to carry out early assessments of mathematics ability

Table 5. Relationship between socio-demographic variables and high and low achievement in students aged 5–7 years old

Variable	% of high achievers	% of low achievers	*U*
Father with university degree	16.7	16.7	196.0
Mother with university degree	25.0	11.1	155.0
Father's job			206.0
Non-qualified job	30.4	37.5	
Low-qualified job	56.5	37.5	
Middle-qualified job	8.7	12.5	
High-qualified job	4.3	12.5	
Mother's job			188.0
Nonqualified job	60.8	75.0	
Low-qualified job	21.7	12.5	
Middle-qualified job	13.0	6.3	
High-qualified job	4.3	6.3	
Number of children in the family (1, 2, & >2)	29.2	33.3	
	58.3	61.1	
	12.5	5.6	.000
Birth order (youngest & eldest)	62.5	27.8	200.0
	20.8	44.4	
Number of computers at home (0–1 or ≥ 2)	8.3	16.7	
	12.5	0	127.0*
Hours watching TV (0–1 or ≥ 2 per day)	58.3	50.0	193.0
	41.7	50.0	
Frequency of teacher visits (1 or ≥ 2)	33.3	5.6	140.0
	37.5	55.6	
Family model			213.5
Mother and father	78.6	57.7	
Single mother or father	3.6	7.7	
Divorced	3.6	7.7	
No answer	14.3	26.9	

$^{*}p < .02$.

to identify children at risk of mathematics learning difficulties as early as possible in their school life so that specific intervention programmes can be implemented to improve their mathematical achievement.

Our results also demonstrated the predictive capacity of the ENT and its utility in the early evaluation of students with learning difficulties in mathematics. Nevertheless, we suggest that this early assessment by means of the ENT should be complemented by a detailed evaluation of the mathematical learning characteristics of the student. The results of this in-depth combined assessment should enable educators to implement a more specific and tailored learning programme to address the mathematical learning difficulties of each individual student. For example, if one student scores poorly in verbal counting, this can be confirmed with a more specific evaluation using the Tedi-Math test (Grégoire, Noël, & Nieuwenhoven, 2005) or the Tema-3 test (Ginsburg & Baroody, 2003), which allow the evaluator to assess more components of the early acquisition of mathematics (numbering skills, number-comparison facility, numeral literacy, mastery of number facts, calculation skills, and understanding of concepts). If the initial finding is confirmed, then specific verbal counting activities can be designed and well-known mathematical concepts can be introduced using detailed training programmes such as those described in Dowker (2008), Navarro, Aguilar, Ruiz, Alcalde, & Marchena (2005), Shayer and Adhami (2010), Wright, Stanger, Stafford, and Martland (2006), and Van Luit (2006). These are very specific training programmes for the different areas of early learning of mathematics that can be used to help LA students.

With respect to socio-demographic issues, the difference in the number of computers at home between HA and LA students was found to be important. It was found that there were frequently no computers in the homes of LA students. When homes with two or more computers were compared with those with no or one computer, the difference was significant. In contrast, an analysis of the data for the variable 'family model' found that there was no statistical significance between LA and HA students.

From the educational point of view, we believe that the findings of this study could be useful for educators because the results of the ENT assessments demonstrated that about a quarter of the LA students (28%) continued to have learning difficulties in mathematics despite participating fully in the regular school programme. This suggests that evaluation and early intervention could potentially reduce the number of students with continuing learning difficulties in mathematics. The results indicated that some students started compulsory schooling (6 years old in the Spanish school system) without sufficient basic knowledge of counting and the basic numerical facts that were evaluated by the ENT. The learning difficulties of these students continued into elementary school because they had been unable to learn some numerical concepts and procedures before they started school in grade 1.

The results of this current study should be interpreted in light of several limitations. Just three schools in one district were used for gathering data, and further research with more schools should be convenient in order to generalize results. However, this research has enabled us to draw some conclusions that could help future investigations in the field of early mathematics. First, the differences in mathematical knowledge that were identified among students in kindergarten remained when the students finished first grade. An easy-to-use tool, such as the ENT, could provide teachers with useful information about early poor achievement in mathematics. Each component of the ENT provides support for developing early instructional programmes in mathematics to reduce those differences. This early screening of mathematics learning capabilities can highlight the existence of specific difficulties and the results could be useful in finding ways to help students overcome learning obstacles. The main target should be to identify and develop abilities and competencies for subsequent success in mathematics when the topics become more abstract (fractions and proportions, percentages, geometry, etc.) in the fifth and sixth grades. Although, the early identification of HA (70%) and LA (28%) students does not necessarily guarantee that, after intervention, the LA students will achieve the same as HA students or substantially improve their grades in higher school grades, there is good reason to identify LA students who need assistance in learning mathematics. As mentioned above, a better understanding of the level of achievement of each individual student could help educators to implement more effective mathematics intervention programmes at an early stage. Some studies have suggested that early intervention in kindergarten does have some benefits in mathematics achievement (Fuchs & Karns, 2001; Griffin, Case, & Siegler, 1994).

This study did not find a specific socio-demographic profile for HA students or LA students. It is necessary to carry out further research with a larger sample to determine whether social variables are related to the cognitive factors involved in low achievement in early mathematics, as has been done by Kyttälä, Aunio, Lehto, Van Luit, and Hautamäki (2003). In addition, a greater number of socio-demographic variables should be studied (e.g., type of home aid programme, how mathematics is regarded by the parents, private professional tutoring at home, type and amount of homework, etc.). Moreover, a cross-cultural study would be useful to determine the specific socio-demographic variables involved in early mathematical learning because there are some differences between educational systems (e.g., compulsory education in the United Kingdom begins at the age of 5, whereas in Finland and Spain it begins at the ages of 7 and 6, respectively). In any case, we expect that the findings obtained from longitudinal studies will continue to contribute greatly to the development of evaluation methods and intervention programmes in the field of early mathematical learning.

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